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ABSTRACT

Recent increases in the speed and accessibility of computers and networks have made it possible to administer tests on-line. On-line assessment can be conducted in a controlled setting, such as a testing center, or distributed over local area networks or the Internet to libraries and student homes, allowing students the flexibility to complete tests as their schedules permit. While on-line tests can contain virtually any type of question, the easiest test to develop are true/false, fill-in-the-blank, and multiple choice formats. Advantages of on-line tests include time savings for instructors and students, as well as increased learning opportunities for students in that the tests offer immediate feedback and do not take up class time. There are disadvantages to on-line testing for students, however, including the problem of procrastination, the lack of universal computer access and skills, and less flexibility in test-taking strategies. Disadvantages also exist for teachers, including problems with security and computer hardware, and issues related to "debugging" testing programs to ensure correct feedback and scoring. Tools for developing on-line tests include basic Hypertext Markup Language (HTML) with hyperlinked answers; HTML forms with Perl, CGI, or Personal Home Page (PHP) scripts to send feedback to students and commercial test development software. Sample HTML and PHP source code and test screen shots are included. (BCY)

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On-Line Assessment: What, Why, How

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On-line Assessment: What, Why, How

**A Paper Presented at the
Technology in Education Conference,
Santa Clara Convention Center, California
May 6, 1998**

Dottie Natal

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Abstract: Assessment is important, but time consuming, both for student and instructor; however frequent assessment provides students and instructors feedback on progress towards learning objectives. Instructors can develop on-line tests that provide immediate reinforcement, manage scores, and support a range of student learning modalities. This paper, which was designed to supplement my talk, provides an overview and references on how to obtain and use software tools to develop and deliver on-line assessments for your students.

Intended audience: this paper was written for community college instructors.

*All examples of tests from this paper can be found at
<<http://www.imagenmm.com/testing/>>. Feel free to experiment with these
examples, borrow and reuse them on your own web pages, post questions or
email questions to the author.*

Common Practice: Janice Smith, a history instructor, uses a word processor to write the questions for her test (a combination of multiple choice and short essay.) She prints out a copy of the master on her printer, takes it to the copy center, and has it photocopied for her students. On exam day (a Thursday), she passes it out to students who grab their pencils and pens, laboriously write in the spaces provided, and turn them in at the end of the hour. Janice then takes them home, reads them (or attempts to read their squiggles!) and marks them up. She pulls out her roll book, looks up each name, writes in each score.

Next class period (a Tuesday, five days later), she spends half of the class period talking about the test—what problems were most missed? What were they confused about? Students who did well on the test are bored and spend the time reading or doodling. Some students do not get their questions addressed, as there were no other students missing that particular question.

Marty, a student in her class, doesn't like taking her tests. His motor skills for writing are not good, and without a spell checker his dyslexia makes it very difficult for him to write a coherent exam. Alexa, on the other hand, loves the exams. She likes to read the whole thing, answer the questions that she knows first, lightly mark in the margin for the ones she is not sure of, and then go back and answer them after she finishes the essay section.

Alternate Practice: Maria Reyes is also a history instructor. She uses a multimedia CBT tool for creating her student tests. She not only types in the questions and answers for the multiple choice part of her test, but also writes a paragraph explaining why the answer chosen was correct or incorrect. She includes a small clip from a video that students saw during class in one of her questions which the students must review and then provide a short essay describing the context of the clip. She emails it to the campus testing center. On Thursday, students are instructed that they must schedule an hour or so in the testing center by Monday evening.

On Tuesday morning, Maria logs into the test center computer, types in her password, and reviews the results. She prints out the essay answers and reads them over, marking them with her pen (she prefers to do it this way rather than reading them on the computer.) She inputs her scores for the student essays into the software, then prints the score summary for the exam, noting which questions were most often missed. Out of curiosity, she also prints out a report which shows the average amount of time for each question that was taken, and is surprised to see that one essay question required two thirds of the average test taking time. Because she did not specify a time limit, she sees that student completion times ranged from 18 minutes to almost two hours. In class, she talks for a few minutes about the essay question that took so long and hands back the essay portion of the test.

Anita, a student in Maria's class, doesn't like on-line tests. She never really liked computers, anyway. She feels discouraged when the computer tells her that she got an answer wrong. Jose, on the other hand, really likes these tests. He just learned how to type (sort of), but even though he is new to computers he thinks it is fun. And, he likes it that he can take his time to carefully read and think about the questions. He is still learning English, and having time to really think and compose answers really helps him.

What is on-line assessment?

Recent advances in computer technology have led to a revolution in the way that information is disseminated, accessed, and used in business and leisure activities. As these technologies become available in the community college system, some teaching and learning activities can also be made more efficient and effective.

One component of teaching that has undergone little change over the years is student assessment. In general, instructors still make up their tests shortly before exam time, reproduce the tests, and pass them out to students. Class time is required for students to take the test, and students are limited to a certain amount of time. Instructors then collect the exams, laboriously grade them, mark the scores in their grade books (usually by hand), and then tally scores at the end of the term to assign grades. Modern technology plays little part in this process; perhaps the instructor includes some diagrams or pictures in the test that would have been difficult to include prior to use of word processors, and perhaps the teacher enjoys increased productivity in developing tests but using copies of the previous version of the test as a starting point. The most technologically liberated instructors may even use a grading program or a spread sheet to keep track of scores, but the amount of time used for grading, record keeping, and reviewing tests with students has changed very little over the last 15 years.

On-line assessment techniques—administering tests through computer technology over the Internet or a local area network (LAN)—offer teachers and students more effective, efficient means of administering, tracking, and taking of tests.

Background of on-line assessment

On-line testing has only been possible (in a practical sense) for a few years, although the ideas have been around for some time now. Recent developments which have made on-line testing feasible include the increased speed and power of modern computers, accessibility of the Internet and/or LANs on campuses, libraries and homes, availability of low cost computer systems, acquisition of technology by schools, student prior experience with technology, and the availability of easy to use software for on-line test development.

On-line testing and distance education courses

The concept of on-line testing is currently being addressed by many instructors and colleges for the distance education courses they are offering. I conducted an informal survey of colleges offering distance education courses to see what policies are now in place or being discussed and found various models being used:

- Authorized Testing Centers—many distance education courses which rely strongly on computer technologies for course delivery and interaction have students attend an authorized testing center where they can be proctored during testing (on-line or pencil and paper tests.)
- On-line testing—other instructors offer students tests which they can take online (un-proctored)
- Less formal assessment—one means of getting around the problems associated with testing students that are not on campus is the use of other, alternative forms of assessment (portfolios, participation in online discussion groups, etc.)

On-line testing for college courses physically attended by students

Examples of on-line testing in other college courses are difficult to locate. A literature search as well as Internet searches turned up little, and although I attempted to collect a sample of sites from the Internet, I had little luck. Undoubtedly, there is on-line testing being conducted in various courses, but such testing may not be widely "advertised."

As the instructor of a multimedia authoring course at Allan Hancock College, I have been conducting on-line tests with students for the last term using a variety of software tools to develop the tests. The construction of the tests are explained in more detail later in this paper, and will be demonstrated during my talk. I give my students weekly quizzes, and I use the results of the quizzes to identify areas of teaching that have not been as clear as they should have been. Each quiz is graded, and students are required to take each quiz each week, but only the fact that the test was taken is used in grading (not the actual score.) My intent was to research the acceptance of this testing, experiment with different methodologies for developing and administering tests, and compare the time and effort required to develop and administer these tests in comparison to the "normal" pencil and paper tests.

With the student population that I am working with—mostly graphic arts students who want to learn about multimedia—I knew that I would not need to be concerned about the students' ability to use computers. The nature of the course required them to have already mastered basic competencies with the computer (typing, using the mouse, understanding what to click on, etc.) I also required them to use a message board system that I established for the class (logging in at least once per week and posting a message.) This component of the course was designed to help students gain the skills they would need to be successful doing multimedia (understanding of newsgroups, how to post messages, how to reply to postings, how to obtain product information, etc.)

In my class of 26 students, all but five had Internet access from their homes or offices (most of my students work.) Of the five without computers or Internet access, all but one were able to access the Internet from a friend's house, the school library, or the public library. All students had email addresses (two obtained them after the term started.) Only seven students had used newsgroups prior to the class. None of the students had had on-line testing in any other course.

Computerized Adaptive Testing (CAT)

One field of on-line testing, known as "computerized adaptive testing" has been used in educational research since the 1970's but is still not widely used in schools or testing centers. I do not advocate that teachers develop CAT, due to the complexities of scoring and programming they entail. However, I present the concept in this paper for those interested in learning about it, and especially for administrators that may be interested in the concept for larger testing environments.

Adaptive testing means that the sequence of test questions presented to each student and the questions themselves will vary because they are based on responses to prior test questions. Each question is automatically chosen to yield maximum information about the examinee, based on the skill level indicated by the examinee's answers to previous questions. Although fewer questions are presented for each test than would be given in a paper-and-pencil test, accuracy is maintained.

According to the Educational Testing Service (ETS), "students are tested more quickly, even though the tests are untimed, and are not frustrated or bored by questions that are too hard or too easy. The difficulty of the questions is quickly and automatically adapted

to the capability of the individual student. So, challenging tests corresponding to each student's skill level are always provided."¹ On October 11, 1997, the GMAT (the world's most widely used graduate school business exam) became a computer-adaptive test.

Adaptive testing is really only practical for large group testing environments, such as entrance exams, where the time of developing the test is cost effective. For effective adaptive tests to be developed, test questions which cover the broad range of skills or knowledge must be developed. These must be sorted into item pools, and graded according to difficulty level. Their construction is very complex and time consuming.

From the perspective of the test-taker, a test algorithm for a pencil and paper test is simple to state:

1. **How to Start:** Answer question #1.
2. **How to Continue:** Answer the next sequentially numbered question.
3. **How to Stop:** After answering the last question.

Of course, in reality many examinees use other, more complicated strategies than this, such as skipping hard questions until later, marking questions for later review, etc. For an adaptive test, the algorithm looks like this:

1. **How to Start:** Specify an initial estimate of student proficiency; this specifies the initial test question.
2. **How to Continue:** Estimate proficiency after each item response. Choose the remaining item that is most informative near the previous question to be administered next.
3. **How to Stop:** When the precision of proficiency estimation is adequate, or when some number of items has been administered.²

Needless to say, the scoring of such tests is also complex (students answer different numbers of questions of different levels of difficulty.)

Current technologies used for on-line assessment

On-line assessment can be conducted in either a controlled setting (such as a computerized testing center on campus or a general purpose computer lab with LAN or Internet access), or in an uncontrolled setting (computers in the school libraries, public libraries, homes of students, drop-in computer labs, etc.) Computerized testing does not require a top-end computer; any computer manufactured in the last five years is probably adequate for this use, and new computers can be purchased for less than \$800 that are more than adequate for these (and other) purposes.

Many software tools exist for creating tests, and the prices of the tools range from free to thousands of dollars.

Types of computer-assisted assessment items

The variety of possible computer-assisted assessment instruments that can be designed are limited only by the imagination of the instructors developing the tests. Any test that is currently used is a likely candidate. Tests can contain:

- True/false items

¹ From an Internet search of <<http://www.ets.org>> for "Adaptive Testing," 20 April, 1998, yielding page <http://www.ets.org/verity/vdkw_cgi/xb03dabe2-3929/Search/3949124/3#HL0>

² Wainer, Howard (1990.) *Computerized Adaptive Testing, A Primer*. (pp 105, 108) Lawrence Erlbaum Associates: Hillsdale, NJ.

- Multiple choice items
- Fill in the blank
- "Drag and Drop" matching
- Media (such as sound, video, animation, photographs, diagrams)
- Interactivity (such as hyperlinks, clickable diagrams, etc.)
- Essays
- Peer-evaluation environments (where students post answers to questions and receive feedback from other students, either by name or anonymously)
- Tools (such as spell checking, dictionaries, spreadsheets, etc.)
- Immediate feedback and test results

The easiest tests to develop and score are true/false, fill in the blank, and multiple choice tests (just as for pencil and paper tests.) Also quite easy to develop are media rich tests—such as a test that shows a video clip, which students then respond—however, these tests are more difficult to deliver as they require a fast network or Internet connection.

Examples of tests that might be quite easily developed are:

- A botany course where the instructor takes leaf photographs that are to be keyed by students. The test consists of showing a leaf photo along with a diagram of the key, and students must click on the correct branch of the key for the leaf shown. This test could have 50 different plants, and students would be randomly assigned 6 plants to identify. Students could be permitted to take the test as many times as needed to pass.
- An algebra quiz in which the students answer multiple choice questions. Each time a question is answered, students would be given feedback on whether the answer was correct or incorrect, and shown how to work the problem.
- An English essay exam, in which students are asked to read and analyze a poem. The poem is contained in the test, and unfamiliar words or phrases are hyperlinked to definitions.
- A combination multiple choice/short answer exam for a speech class, in which students review video clips of other students giving talks, and identify specific elements in the talks.
- A series of multiple choice tests for a self-paced child development course, in which students read a text book and supplemental materials and then take the test for that section. The course is designed as a mastery course, and students not passing a test must re-take the exam no sooner than five days later. Test questions are randomly pulled from a pool of questions so that each retaking of the test provides a different test.
- A history exam, where each student must answer a different essay question and post their answer, and then over the next two days read and critique three of their peer's answers to their questions (resulting in every question being peer reviewed by three different students.) Students then have two days to rewrite their essays based on the feedback. Teachers then read and grade students on their final essays and peer review of other student essays.

Why use on-line assessment?

What advantages do on-line assessments have over the current pencil and paper tests you now employ? You may find that on-line testing offers three main benefits: time savings for the instructor; time savings for students; and increased learning opportunities for students.

Whether you obtain these benefits depends upon the courses you are teaching, instructor familiarity with computers, student access to computers, your own access to computers, student familiarity with computers, and many other factors. In my own experiments I found that students with easy Internet access generally liked using on-line testing. On our message center, I posted the question:

"I'm giving a talk at the Technology in Education conference next week about the concept of on-line testing (like the quizzes we are using in this class.) One student I talked to feels like most students are procrastinators, and having them available to take any time just means students won't do them in time. She also felt like she prefers tests in a classroom setting, where the instructor can answer questions and the other students are present. How do you feel about it? If you had a class in which your grades depended on on-line tests, how would you like it? I would love any feedback I could get on this question! Thanks!"³

"Dottie, I really like online testing. No panic, no stress and you don't have to drive somewhere. You can take the test in your own home at any hour and can take the time to thoroughly understand the questions. Personally, I have gotten into the habit of checking the message site daily to keep up on class happenings, so I take the tests straight away. Printed quizzes are things that I lose, so this is much better. And I love the immediate results. It lets you know where you need to focus attention. I'd like to think that online testing is part of the future in education."

"Dotty, I think that the online idea is great if everyone has access to a computer and don't mind taking tests without the teacher around. I personally like it because I can take it at home at my leisure. I have heard other students complain because it is hard to get to a computer and it somewhat inconvenient. The message center is a great idea!"

"If I had a class in which my grades depended on on-line tests, I would like to be able to talk about the test in class to avoid problems or misunderstandings later on, or maybe have the possibility to get back to the instructor if there is a problem before having to submit the final version of answers. The thing I like most about the on-line tests is getting the results back right away as well as getting immediate feed-back. It helps me learn better."

"While I will be the first to admit that I tend to wait until Friday to take the quizzes, mainly so I think I have caught up with the reading and am ready to go, I really like the online testing. Especially, I like the fact that the quizzes immediately update and tell me how I did."

"I like the On-line quizzes. I agree that taking the tests at your leisure and getting immediate feedback sharpens the learning curve. This also allows the students and instructor additional follow-up during the next class time, if they want to expand on

³ I had actually not heard any negative comments by students in the class, but experience has taught me that if you word a question using a negative response example, students are more likely to give negative as well as positive feedback.

the topics. The only disadvantage would be to the students who don't have easy access to on-line resources. Having anytime access to the quizzes as opposed to "one-shot", like the Intro to MM midterms last class is better, too. It makes technology seem "friendlier" and allows you to peruse the topics at your leisure before putting your fingers to the keyboard."

"This was great! I was able to take a break at work and buzz through the quiz; really convenient and the instant correction on wrong answers is cool. I think if we survive satellites being blasted out of the sky by meteor showers, the year 2000 "00" thing on computer clocks and various other glitches, technology is great!"

Benefits for students

- *"Any time, any place" testing*—many students have very busy schedules⁴, and the ability to take tests when they are prepared, relaxed, and have sufficient time can lead to decreased test anxiety⁵, higher levels of confidence, and better test performance.
- *Support for ESL students*—the use of on-line testing provides ESL students with more opportunities for success, as they can take time to really think about a question before answering, use dictionaries and other reference materials, and work slowly without embarrassment on the problems.
- *Support for students with disabilities*—students with physical or learning disabilities also benefit from on-line tests, as they can take the time they may need to answer questions⁶. Many campuses also offer centers for disabled students in which access to Internet terminals with special features (such as the ability to read aloud text) is available.
- *More effective use of time*—class time, when spent taking quizzes and tests, is not well used. Students benefit more from direct teaching, small group work, and hands-on experience with materials relevant to the class. Students needing little time to complete a test can do so quickly, while students needing more time can take the time. Also, when the test provides the feedback on correct and incorrect answers, class time does not need to be spent going over questions from the test.
- *Immediate feedback*—feedback is most effective when provided immediately after a quiz or test⁷, but "traditional" testing techniques offer delayed feedback only.
- *Directed feedback*—if you build the feedback directly into the tests, students can learn from the questions they miss, making these tests effective teaching tools as well as assessment tools.
- *Access to tools*—many of your students have grown up with computers, and feel much more comfortable⁸ composing text on the computer.

⁴ Statistics show that the largest increases in student population is for students over the age of 25, and that most adult students are juggling work, studies, and family life.

⁵ Sogunro, O. (1998.) Impact of evaluation anxiety on adult learning. *Journal of Research and Development in Education*, 31 (2), 109-120.

⁶ Lewis, R. B. (1993.) *Special education technology: Classroom applications*. Brooks/Cole Publishing: Pacific Grove, CA.

⁷ Mory, E. (1996.) Feedback research. In David H. Jonassen, (Ed.), *Handbook of research for educational communications and technology* (pp. 919-956). Macmillan: New York.

⁸ Selwyn, N. (1998.) The effect of using a computer at home on students' school use of IT. *Journal of Research in Education*, 58, 79-81.

Drawbacks for students

- *Procrastination*—many students wait until the last minute to complete assignments; this may lead to a problem of some students not completing the tests in the allotted time⁹ due to equipment or access problems.
- *Computer access*—students without easy access to computers are at a disadvantage to students with access at home or work. If your campus does not offer access which is available during school hours as well as weekend and/or evening, then on-line testing is not an option for you.
- *Lack of computer skills*—in classes where basic computers skills are prerequisite or part of the course, it is safe to assume that students will already have the computer skills needed for on-line testing. In general education courses, students may not have the necessary prerequisite skills to use on-line testing. Depending on the type of testing you do, these skills might include: ability to log onto the Internet; ability to type a URL into their web browser; understanding of hyperlinks or buttons; understanding of scroll bars; ability to type. Students may be embarrassed to admit lack of these skills.
- *Inability to use standard test-taking strategies*—students may be unable to use typical test-taking strategies (such as skipping questions, doing the hardest problems first, etc.)

Benefits for instructors

- *Decreased record-keeping time*—depending on how you implement the tests, you can decrease or eliminate the grading and record-keeping time needed for testing.
- *Reusable test questions*—instructors can create a databank of questions that can be used and reused.
- *Easier reading*—a typed, spell-checked essay is much easier to read than a hand writing.
- *Media inclusion*—with on-line testing, an instructor can include video, audio, color graphics, charts, etc. which would be impossible or too costly in a printed exam.
- *Increased teaching time*—when class time does not need to be spent for diagnostic or formative assessments and for going over the results of the assessments, there is more class time available for lecturing, demonstrating, group work, and other activities.
- *Better test design*—refocusing on the design of testing generally leads to better test designs¹⁰. Newly designed tests may support a wider range of students (visual learners, auditory learners, students with disabilities, ESL students, etc.)
- *More frequent assessment*—the ease of creating, administering and grading on-line assessments can make more frequent assessment possible, leading to better feedback on teaching and learning.
- *Better statistical feedback*—depending on what tools you use, you can find out things such as: how long did students spend on each question; what questions were most often missed, and what answer was chosen instead of the intended answer; how long did the test take for the average student, the fastest students and the slowest students.

⁹ Blockbuster recently increased the amount of time that videos can be kept at home, because research showed that the longer people have to return them, the more likely they are to return them late, thus increasing Blockbuster revenue (through late fees.)

¹⁰ Wesley, M.T. (1995.) *The virtual classroom, authentic assessment, and learning process control in online teacher development to support Internet telecommunications in education*. Paper presented at the mid-south Educational Research Association Annual Conference (Biloxi, MS.)

Drawbacks for instructors

- *Security problems*—if the tests are graded, some students may be tempted to find innovative methods of cheating. This means that if you administer the tests over the Internet, you may need to employ security measures (encrypted questions and answers, for example.)
- *Unexpected results*—instructors, who are themselves new to on-line communications, may find that student written discourse is not up to their standards without realizing that they have bumped into a new genre of writing. On-line communications tend to be terse, with less regard to punctuation, spelling and grammatical construction than other, more formal types of writing. It is important to set the stage, informing students of your expectations, and changing your expectations where appropriate.
- *Hardware problems*—if the instructor's link to the Internet goes down, or the computer crashes, or the server goes down, the instructor could find that a quiz date must be missed or may need to slide (which would be a major problem in many courses.) Unless the computer system which the instructor is using is robust, on-line testing may not be a viable option.
- *Debugging problems*—on-line tests may require some "debugging" (fixing problems, such as a correct answer scored as incorrect, the wrong feedback given to a question, broken links on a web page, etc.)

How do you create on-line assessments?

Depending upon the settings under which the tests will be administered you will have various options. If students have access to Internet terminals on your campus, then this is a good option (as many of your students will also have access to the Internet from home or work.) Of course, this means of testing is like other "take home test" situations; you can't be certain if the answers you are obtaining are the student's or a group effort. If you have a computerized testing center on your campus or a multipurpose/open access computer lab, you may be able to schedule time and resources for on-line testing. In this case, you might be able to use the centers for secure, proctored testing of students.

If students are using a lab on campus, the lab may be running Netware or some other networking protocol, or the lab might be running TCP/IP with access to browsers (such as Netscape or Internet Explorer), or a combination of both. If the server for your Internet or intranet files is located in the same LAN and the bandwidth of the network is wide (that is, the network is very fast), you may be able to serve video and other "bandwidth greedy" applications. On the other hand, if the students are to be working from home, or the server is not accessible on campus through high-bandwidth lines, then you should probably stay away from video and use less "data intensive" forms of on-line tests.

Choosing appropriate development tools

Depending on the environment under which the testing will occur, your own experience and understanding of computer technology, your access to technology, and your budget, you have various choices for tools to use. Following are some examples of useful tools, along with explicit directions on how you would actually create the tests.

plat-form	technology used	benefits	drawbacks	security	cost
Inter-intra-net	simple HTML files, hyper-linked answers	easy to create (use Word, Netscape¹¹, Pagemill¹², etc.)	no "accounting" method (except logs, self report)	none	free ^a
Inter-intra-net	Perl ¹³ (cgi-bin) with forms, programmed by instructor	- flexible - powerful - runs with any browser	- difficult to learn - hard to debug	depends on program-ming	free ^b
Inter-intra-net	forms + cgi-email ¹⁴	- flexible - easy to learn - runs with any browser	no immediate student feedback	not an issue	free ^b
Inter-intra-net	forms + PHP ¹⁵	- can store q & a's in database, randomize - runs with any browser	somewhat difficult to learn (not for computer novices)	depends	free ^{b,c}
Inter-intra-net	online testing & class site commercial companies ¹⁶	- easy to use - powerful - all the details are taken care of for you	may be less flexible than other methods	depends on program-ming	vary (more than \$1000)
Internet or PC LAN	Commercial software for CBT & tests ¹⁷	- flexible - powerful - easy to learn	may not work on all machines	secure	\$695

a. Using tools that are freely available or already on your computer b. Requires FTP and Telnet access to a properly configured server c. Requires webmaster to set up server with appropriate software

Table 1. Some options for creating on-line tests.

When you first begin gearing up to use on-line tests, there are conditions you should probably test (depending on how you will be setting up testing) before the students begin using the system in order to decrease potential frustration. For example;

- What happens when a lot of users attempt to access the same test at the same time?

¹¹ Visit <<http://www.netscape.com>> to obtain Netscape's latest versions of browsing/editing software (free).

¹² Visit <<http://www.adobe.com>> to read about the current version of Pagemill.

¹³ Using your favorite search engine on the Internet, search for "Perl primer" (using the quotes) to locate instructions on how to develop Perl scripts.

¹⁴ Visit <<http://web.mit.edu/wwwdev/cgiemail/>> for instructions on how to use CGIEMAIL (and give this information to your web master to have her install the scripts on your server.)

¹⁵ Visit <<http://simac.kaist.ac.kr/php/doc.html>> for instructions on how to use PHP (and give this information to your web master to have her install the scripts on your server.)

¹⁶ Some of the best sites I have found are: Web Course in a Box <<http://www.madduck.com/>>, WebCT Development (\$500 for 100 students/year) <<http://homebrew.cs.ubc.ca/>>, Interactive Learning Network <<http://courses.lightlink.com/web/index.htm>>, and TopClass (\$2175 for 100 students/year) <<http://demo.wbtsystems.com>>

¹⁷ Asymetrix Assistant is perhaps the most well developed and powerful of these products: <<http://www.asymetrix.com/products/toolbook2/assistant/>>; however, you must have a PC running Windows to develop the web site (but it will play back on Macintoshes)

- What happens if more than one student finishes a test at the same time? (Make sure that if you are using a database it is set up to lock out simultaneous changes and display an appropriate message to the user temporarily locked out.)
- What happens if the same student takes the test a second time?
- What does the test look like when using different browsers on different computers?
- How long does a page take to display when the student is using a 28.8 baud modem? A 14.4 baud modem? (Don't use unnecessary graphics!)
- Does the application work with older versions of browsers?
- Do you have a policy in place for when students run into difficulties (browser crashes in the middle of test, student cannot get to a computer because the school network is down, etc.)

Internet/Intranet tools

If students have access to the Internet or a campus intranet, this may be your best choice of an environment. Tools for creating tests are available and abundant, and many of the tools are free! During my workshop I will be demonstrating simple HTML programming of on-line tests, using HTML forms plus CGI Email, using forms plus PHP programming, accessing web sites that provide support and storage of your course materials, and use of Asymetrix Assistant software.

Creating simple HTML linked on-line quizzes. You can use any HTML editor, such as Netscape's HTML editor (free, built into versions 3 and 4 of their browser), Microsoft Word HTML output (in the current version of Word on the PC and Macintosh), Adobe Pagemill (about \$50), Claris Home Page (about \$50), or many other products. The basic steps are:

1. Write your test questions (multiple choice/true false),
2. Write out the answers to the questions,
3. Link each answer to another page (such as "quiz1a.html" if they choose answer 1.a., "quiz1b.html" if they choose 1.b., etc.,
4. Create the linked pages with appropriate feedback ("No, this answer is wrong because...."),
5. Add a link at the bottom of the page to go to the next question,
6. Follow the same process for each of the questions in the quiz, and
7. Upload the files to your server.

See figure 1 for an example of such a web page. The problem with this technique is that there is no mechanism for grading or keeping track of the student scores. You may be able to access your web site log file and read how many visits each of the pages received, and thus obtain a count of the correct and incorrect answers. Note, however, that many students will use their BACK buttons to revisit any question that they missed, so your count will add up to a lot more than the number of students in the class. Also, my experience has been that some students will take a test many times if they are permitted to do so, even if the test is ungraded (at this time I have not analyzed why they do this, or what type of student does this, I am just aware that it happens quite frequently.)

Combining simple HTML linked on-line quizzes with CGI Email. Another very simple method of obtaining results from quizzes is to use HTML forms along with CGI Email, and then have the code email the results back to you. The steps are:

1. Create an HTML file using form fields (buttons, fill in the blank, text fields, click on the picture, select from a list, etc.),
2. Edit the HTML source file and name each of the questions and values for responses,
3. Create a text file with all of the questions and values for the responses and a header to mail the results back to you,
4. Create a file that gives feedback to the student on the test, explaining each answer, and
5. Upload the files to your server.

See figure 2 for an example of such a web page. The drawback to this technique is that you cannot branch for different answers (unless you want to have them enter their name on each page and receive a separate email message for each question for each student), so students will receive a "generic" feedback page. The HTML code for the page will look something like the code shown in code listing 1 (don't let the "secret codes" scare you—the HTML editor creates them, you just have to add in the names for the questions and answers and the <FORM METHOD=...> line, exactly as shown here.)

```
<HTML>
<HEAD>
<TITLE>Quiz 1</TITLE>
</HEAD>
<BODY BACKGROUND="b100.gif">
<FORM METHOD="POST" ACTION="/cgi-bin/cgiemail/quiz1.txt" ENCTYPE="x-www-form-
urlencoded">
<CENTER>
<H1>Quiz Number 1</H1></CENTER>
<UL><UL><H2>Multimedia Authoring Course, AHC</H2>
Three questions only in the first quiz--good luck!
<H3>Instructions</H3>
<B>Choose the best answer for each question. Results are emailed to the
instructor and to you. If you think that the instructor's answer is not
really the best answer, email your reason to her for a personal reply.</B>
<P><B>Remember, these quizzes are for the purpose of keeping track of how
well the material is being absorbed by the students, and is used by the
instructor for feedback purposes. Thus, only the fact that you took the
quiz will go into your grade, not the score itself. So relax, become part
of the "cutting edge" of educational practice, and have fun!</B><BR>
<HR ALIGN=LEFT>
<BR><B>1. What is the resolution you should use for the graphic objects
you place in your multimedia project?</B>
<UL><INPUT TYPE="radio" VALUE="a" NAME="q1" CHECKED="true"><B>a. 300 dpi
or higher</B>
<BR><INPUT TYPE="radio" VALUE="b" NAME="q1"><B>b. 150 dpi</B>
<BR><INPUT TYPE="radio" VALUE="c" NAME="q1"><B>c. 72 dpi</B>
<BR><INPUT TYPE="radio" VALUE="d" NAME="q1"><B>d. 60 dpi or lower</B></UL>
<B>2. True or false: A multimedia project created in Macromedia Director
can use buttons, video, sound, animation and text.</B>
<UL><INPUT TYPE="radio" VALUE="true" NAME="q2" CHECKED="true"><B>a. true</B>
<BR><INPUT TYPE="radio" VALUE="false" NAME="q2"><B>b. false</B></UL>
<B>3. "Shockwave" and "Director" are related how? (Shockwave files are
often seen on the Internet as animations.)</B>
<UL><INPUT TYPE="radio" VALUE="a" NAME="q3"><B>a. Director will allow
you to save your work as a Shockwave file</B>
<BR><INPUT TYPE="radio" VALUE="b" NAME="q3"><B>b. They are not related</B>
<BR><INPUT TYPE="radio" VALUE="c" NAME="q3"><B>c. They are two different
multimedia authoring programs</B>
<BR><INPUT TYPE="radio" VALUE="d" NAME="q3" CHECKED="true"><B>d. "Director"
and "Shockwave" are two names for the same software</B>
<BR>
<P><B>Please enter your name:</B>
```

```

<P><INPUT NAME="student_name" TYPE="text" SIZE="35"><B></B>
<P><B>Please enter your email address (check your typing!);</B><B></B>
<P><INPUT NAME="student_email" TYPE="text" SIZE="46">
<P><INPUT NAME="submit" TYPE="submit" VALUE="Submit">
<BR><FONT SIZE=-1><A HREF="quizanswers.html">Click here to see answers
(no peeking! Take the quiz first!)</A></FONT></UL>
</UL></UL> </FORM></BODY></HTML>

```

Code listing 1. HTML source code for HTML form + CIG Email.

This code works in conjunction with a text-only file (also called an ASCII file) as shown in code listing 2:

```

TO: dottie@learnsol.com,[student_email]
SUBJECT: quiz results from student [student_name]
-----
1. What is the resolution you should use for the graphic objects you place
in your multimedia project?
Answer: [q1]

2. True or false: A multimedia project created in Macromedia Director can use
buttons, video, sound, animation and text.
Answer: [q2]

3. "Shockwave" and "Director" are related how? (Shockwave files are often seen on
the Internet as animations.)
Answer: [q3]

```

Code listing 2. ASCII file for CGI EMAIL (needed for code listing 1 to work).

Using HTML Forms plus PHP. Another means of creating tests is to use a simple programming language known as PHP (Personal Home Page construction kit.) In the examples I use here I am using PHP to store the values of the answers students choose in variables in order to branch to correct, incorrect feedback and to save the answers to report back to the instructor using email. Without much more difficulty you can make very complex feedback pages and even store the student answers in a database (but that would take too long to show in a 50 minute talk, so I mention it here for your information only!) Code listing 3 shows an example of the HTML file:

```

<HTML>
<HEAD><TITLE>Quiz 3 (continued)</TITLE></HEAD>
<BODY BGCOLOR="#D8F5F5">
<FORM METHOD="POST" ACTION="quiz3_2.phtml" ENCTYPE="x-www-form-urlencoded">
<CENTER>
<H3>Quiz 3</H3></CENTER>
<CENTER><H3>Quiz 3 (continued)</H3></CENTER>
<B>Question 2:</B> What things do you like <I>best</I> about the class
so far?
<P><INPUT TYPE="checkbox" NAME="2a" VALUE="2a">The pacing of the
course
<BR><INPUT TYPE="checkbox" NAME="2b" VALUE="2b">Working on a project
in a group
<BR><INPUT TYPE="checkbox" NAME="2c" VALUE="2c">Learning how a project
is developed from start to finish
<BR><INPUT TYPE="checkbox" NAME="2d" VALUE="2d">Creating art work,
gathering information, and developing media for our project
<BR><INPUT TYPE="checkbox" NAME="2e" VALUE="2e">Developing the interface
(programming in Director)
<BR><INPUT TYPE="checkbox" NAME="2f" VALUE="2f">Other (please specify):
<BR><TEXTAREA NAME="otherbest" ROWS="5" COLS="67" WRAP="PHYSICAL"
></TEXTAREA>
<BR><INPUT NAME="name" TYPE="submit" VALUE="Next page"></FORM>

```

```
</BODY>
</HTML>
```

Code listing 3. HTML form example to use with PHP.

This listing is used with code listing 4, a PHP file:

```
<HTML>
<? $answers = $2a + $2b + $2c + $2d + $2e + $2f + $otherbest >
<? mail("dottie@imagenmm.com", "quiz3_2 answers", $answers) >
<? if ($2a == "2a"); echo "Hmmm... You may be the ONLY person in the class that likes
it to move this fast!"; endif >
<? if ($2b == "2b"); echo "<P>It is good that you like working in a group, as the
industry tends to be \"workgroup\" oriented. Others in your group can help you when
you run into a problem."; endif >
<? if ($2c == "2c"); echo "<P>Learning how a project is developed from start to finish
can only be done by doing a project. Too bad there is not more time in this
class!"; endif >
<? if ($2d == "2d"); echo "<P>Creating the media that goes into the project is probably
the most time-consuming part of multimedia, but for many it is the most rewarding
part, too."; endif >
<? if ($2e == "2e"); echo "<P>Programming is a complex and often confusing thing to
learn; if you enjoy programming, you will want to continue to learn more about
Director. You must continue to create projects, and increase the complexity of the
projects. You will want to invest in some books that will help you overcome some of
the common difficulties in programming in Director (such as the book recommended
for this course.)"; endif >
<? if ($2f == "2f"); echo "<P>Thank you for submitting an answer to this
question."; endif >
<? echo "<P><A HREF=\"quiz3_3.html\">Go to next page...</A>" >
</HTML>
```

Code listing 4. PHP code example.

Figures 4 and 5 show screens from Eudora (an email management program.) I use a filter for incoming mail messages, automatically sorting all email with "quiz" in the subject line into an in-box for quizzes. These can viewed in alphabetical order to make it easy to mark results in a role sheet.

Using a commercial on-line company that supplies testing software. Figures 6 and 7 show screens from a commercial on-line companies that allows you to administer quizzes, set up message centers, load course HTML pages, etc. Basic steps are:

1. Conduct a web search for companies that support the features you would like to use with your students (URLs for three such sites are listed in the footnotes of this article),
2. Contact the companies, find out current pricing for services,
3. Test the software, developing a sample test similar to one you might want to use with students, following their step-by-step instructions and tutorials, and
4. Purchase the services of the company you like best.

Using Asymetrix Assistant. Asymetrix Assistant is a software tool that provides "drag and drop" creation of quizzes. It supports most web browsers, as is both powerful and easy to learn. The software is \$695, a one-time fee that does not require a per student license fee, as do the commercial on-line sites. The software is designed for authoring courses on the PC Windows platform only, so if you use a Macintosh you will not be able to author with this product (although the resulting lessons can be designed to play back on Macintoshes as well as PCs). Assistant is one product in a full product line which includes Instructor (used for testing as well as computer-based training applications), Multimedia Toolbook, and Librarian (a product designed to keep track of student progress through all of the teaching and testing

modules you create.) Most of the products are fully integrated with the Internet, but also permit you to develop stand-alone CD-ROM courses (which permit you to use video, sound and other media, no matter how slow your network is.) Although there are some competing products on the market, none have the wide range of features and ease of use that Asymetrix products offer. Steps in creating test using Assistant are:

1. Create your project, using their wizard and answering each question,
2. Type in your test questions and feedback (audio and other feedback is supported),
3. Save your project, and
4. Upload it to the Internet.

Some general test design recommendations

The roles of assessment in the classroom vary according to the reason for collecting the assessment information. Three general categories of evaluations are *formative*, *summative* and *diagnostic*¹⁸:

Formative evaluations occur during instruction. They establish whether students have achieved sufficient mastery of skills and whether further instruction in these skills is appropriate. Formative evaluations are also concerned with attitudes students are developing. The purpose of formative evaluations is to determine what adjustments to instruction should be made. Formative evaluations are based primarily on continuous informal assessments.

Summative evaluations occur at the conclusion of instruction, such as at the end of a unit or the end of the year. Summative evaluations are used to certify student achievement and assign end-of-term grades. Summative evaluations also serve as the basis for promoting and grouping students. Unlike formative evaluations, the role that assessment plays within summative evaluations is *not* to establish student proficiency with each skill but instead to provide an overview of achievement across a number of skills.

Diagnostic evaluations occur before or, more typically, during instruction. Diagnostic evaluations test skills and other characteristics that are prerequisite to the current instruction or that enable the achievement of instructional objectives. During instruction, diagnostic evaluations are used to establishing underlying causes for a student failing to learn a skill.

On-line testing can be used for formative, summative and diagnostic evaluation purposes; combined with other formal or informal evaluation methodologies (such as grading of portfolios of student work, evaluating small group products in project-based courses, marking homework assignments, etc.) they can make the process of collecting and maintaining records of student progress and class progress more painless and less time consuming.

When designing your tests, keep in mind special needs students and the effect of testing on this population. Whenever possible, provide multiple cues for students with learning disabilities (such as sound, animation, graphics.) For example, take care that if you use color appropriately—use it to highlight elements, but make sure there is a good visual contrast between the foreground and background, as students with learning disabilities may find low contrast text very difficult to read. Also, stay away from color combinations difficult for color blind or deficient students (red and green combinations.) Because the cost of paper and printing is not an issue, provide plenty of “white space” on each page.

Test to various learning styles¹⁹--much research is now available on the effects of teaching and testing to various types of students. For example, we know that one useful method of conceptualizing the types of learners divides them into four quadrants:

¹⁸ Oosterhof, Albert (1996.) *Developing and Using Classroom Assessments*. Prentice-Hall:New Jersey.

- Divergers—are extremely sensitive to their own and others' feelings; are flexible, adaptable, accepting, and respond to change easily; learn well by working with others; learn well by discussion; use fantasy and imagination as resources; are creative; dislike conflict; work hard to please others; avoid competition.
- Assimilators—need a quiet environment to think and study; like to talk and read about ideas; may seem haughty or arrogant to others; don't become emotionally involved, like to play devil's advocate; admire and support the ideas of favorite teachers, learn best from an "expert"; read avidly; want a quality course of study, expect teacher to be expert; rely on logic; want to be respected for intellectual abilities; have well developed vocabulary; like learning just to learn; need blocks of time to study.
- Convergers—need and enjoy structured situations; like to work with hands-on projects; like clearly defined directions; pay attention to details; must be correct and prepared; look for immediate approval; are always busy, looking for constructive things to do; chew gum, tap pencil, doodle to help concentration; need specific examples to learn a concept; need consistency and predictability; show creative ability by making products that are "real"; like to finish one thing at a time.
- Accommodators—find out-of-the-ordinary answers to problems; are risk-takers in the eyes of others; raise "why" and "why not" questions; love to solve problems; are extremely independent; are competitive with selves; enjoy unstructured activities; show original creativity; prefer to investigate and experiment; can be natural leaders; like to plan their own way of doing things; are very flexible.

Testing in different formats supports students with different learning styles; divergers respond well to interpretive essay tests, assimilators to analytical skill tests, convergers to fill in the blank or objective tests, and accommodators to open-ended and essay tests.

My final recommendations include:

1. If your students have Internet access, experiment with on-line assessment! You may find it adds a dimension to your teaching that you currently miss, and your students may find it helpful.
2. Until you are more familiar with the constraints of student access and readiness to use the computers, don't penalize students for lack of participation in on-line testing; offer students an alternative (such as a printed copy of the test.)
3. Consider having your college invest in programming services; a good programming firm with an understanding of educational needs would be able to customize a web wizard or software template for your instructors for creating on-line tests and other courseware; the school would then be able to use this wizard without any per student fee.

¹⁹ McCarthy, B. (1985.) What 4Mat training teaches us about staff development. *Educational Leadership*, April, 1985, 61-68.

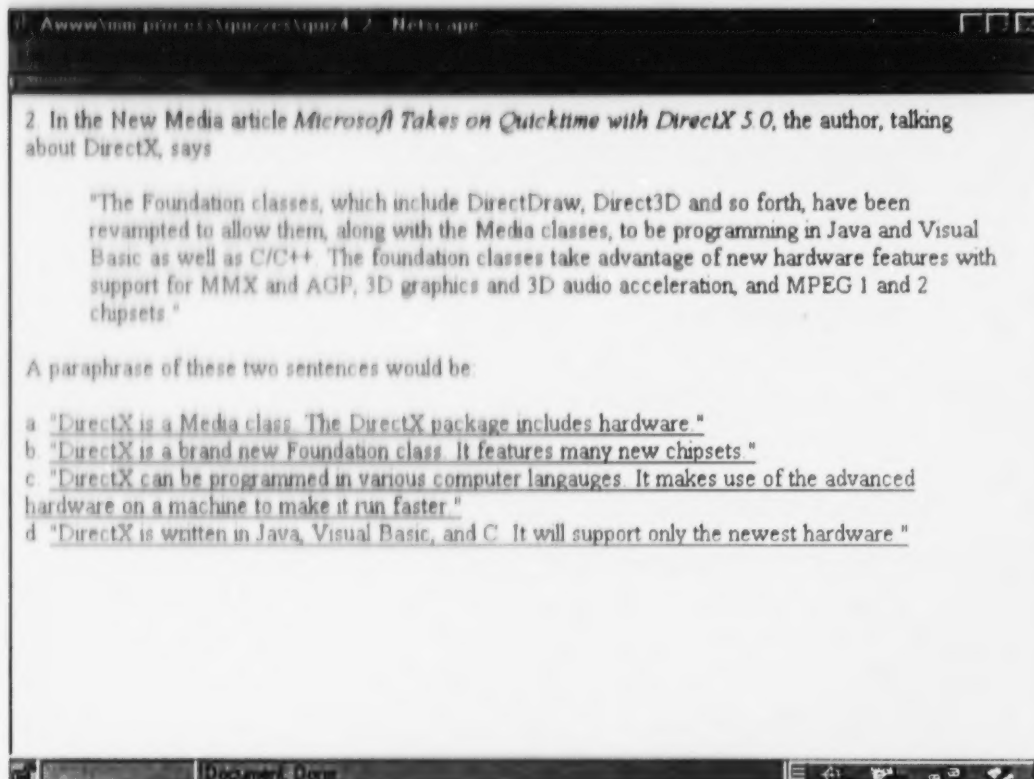


Figure 1. Example of creating a simple, hyperlinked HTML on-line quiz, where each link goes to a feedback page for the chosen answer.

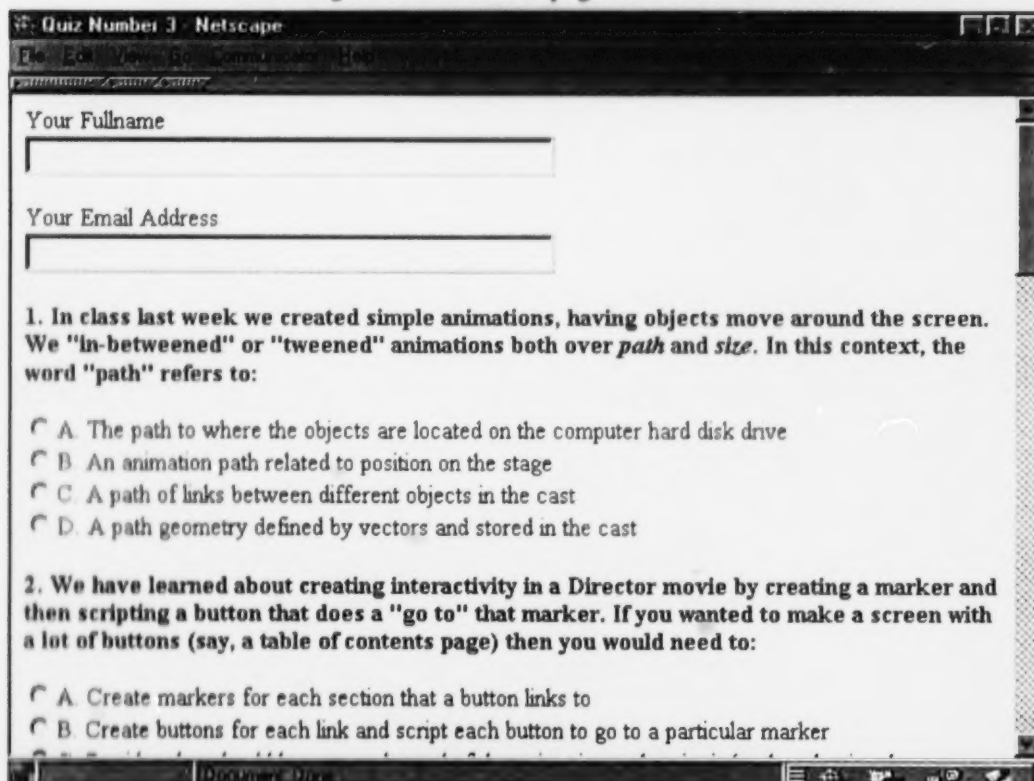


Figure 2. Example of an HTML form using CGI Email, results of which will be emailed to the instructor? ☺

Quiz 3 (continued)

Question 2: What things do you like *best* about the class so far?

☒ The pacing of the course

☐ Working on a project in a group

☒ Learning how a project is developed from start to finish

☒ Creating art work, gathering information, and developing media for our project

☐ Developing the interface (programming in Director)

☐ Other (please specify):

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Figure 3. Example of an HTML form using PHP for branching and e-mailing results to the instructor.

Status	Date	Time	Subject
Un	12:16 AM	4/26/98	1 quiz 3 student name taking test Dyanna Cridelich
Un	03:14 PM	4/21/98	1 quiz 3 student name taking test Elizabeth Johnson
Un	02:14 PM	4/24/98	1 quiz 3 student name taking test Elizabeth Johnson
Un	01:31 PM	4/24/98	1 quiz 3 student name taking test Evvy Boggess
Un	12:36 AM	4/29/98	1 quiz 3 student name taking test Evvy Boggess
Un	02:10 AM	4/22/98	1 quiz 3 student name taking test Jack Finks
Un	12:36 PM	4/22/98	1 quiz 3 student name taking test Kam Jacoby
Un	04:44 PM	4/24/98	1 quiz 3 student name taking test Marilyn Pharis
Un	08:36 PM	4/22/98	1 quiz 3 student name taking test Michael Heffner
Un	05:17 PM	4/22/98	1 quiz 3 student name taking test Ron Horn
Un	12:06 PM	5/2/98	1 quiz 4 from Anita McVey
Un	05:01 PM	5/1/98	1 quiz 4 from Carol Oberdeck
Un	09:12 PM	4/29/98	2 quiz 4 from Carole Barreto
Un	12:42 AM	5/1/98	1 quiz 4 from Clifford Oliver
Un	12:53 AM	5/2/98	2 quiz 4 from Cynthia Valdez
Un	12:58 PM	4/29/98	1 quiz 4 from Dyanna Cridelich
Un	06:12 PM	4/29/98	1 quiz 4 from Elizabeth Johnson
Un	02:49 PM	5/1/98	2 quiz 4 from Evvy Boggess
Un	03:13 AM	5/2/98	1 quiz 4 from Janice Shields
Un	12:29 AM	5/2/98	2 quiz 4 from Kam Jacoby
Un	02:22 AM	5/2/98	1 quiz 4 from Marilyn Pharis

Figure 4. Instructor's e-mail in-box (Eudora.)

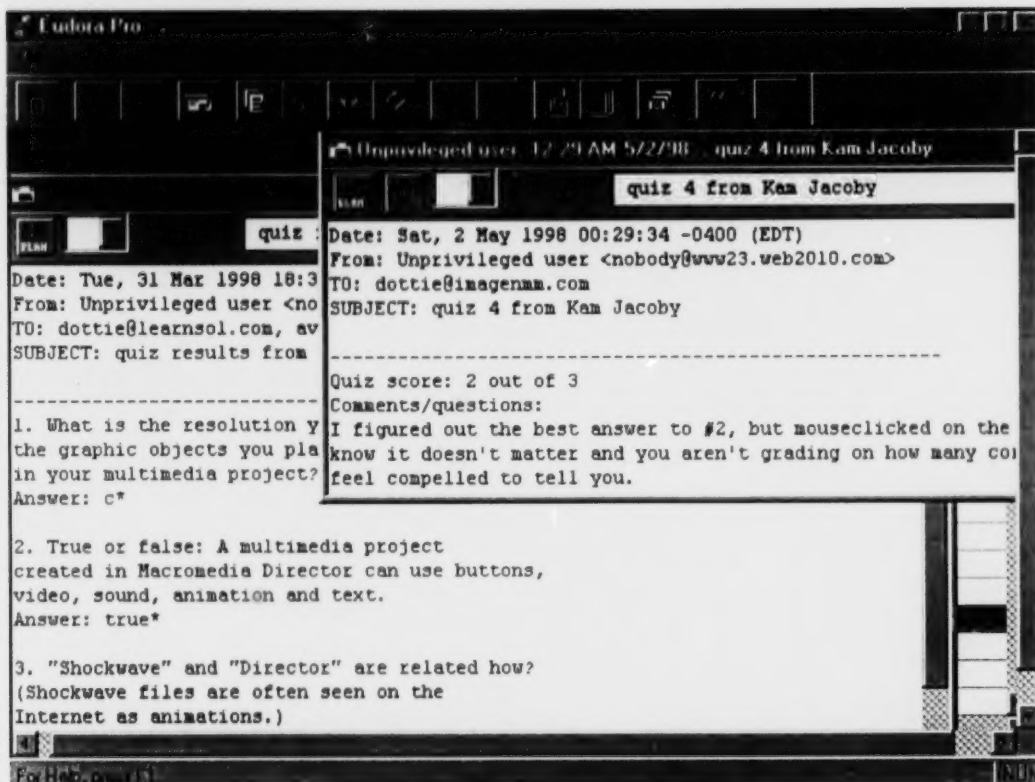


Figure 5. Open e-mail messages.

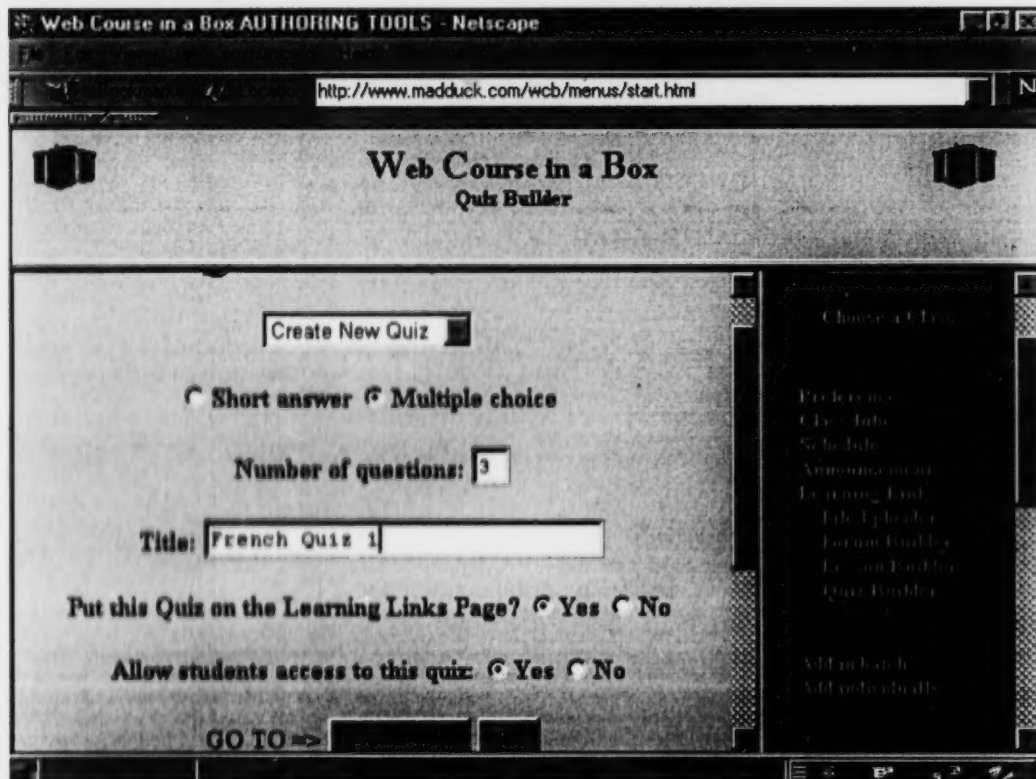


Figure 6. Example of a commercial on-line product screen (Web Course in a Box.)

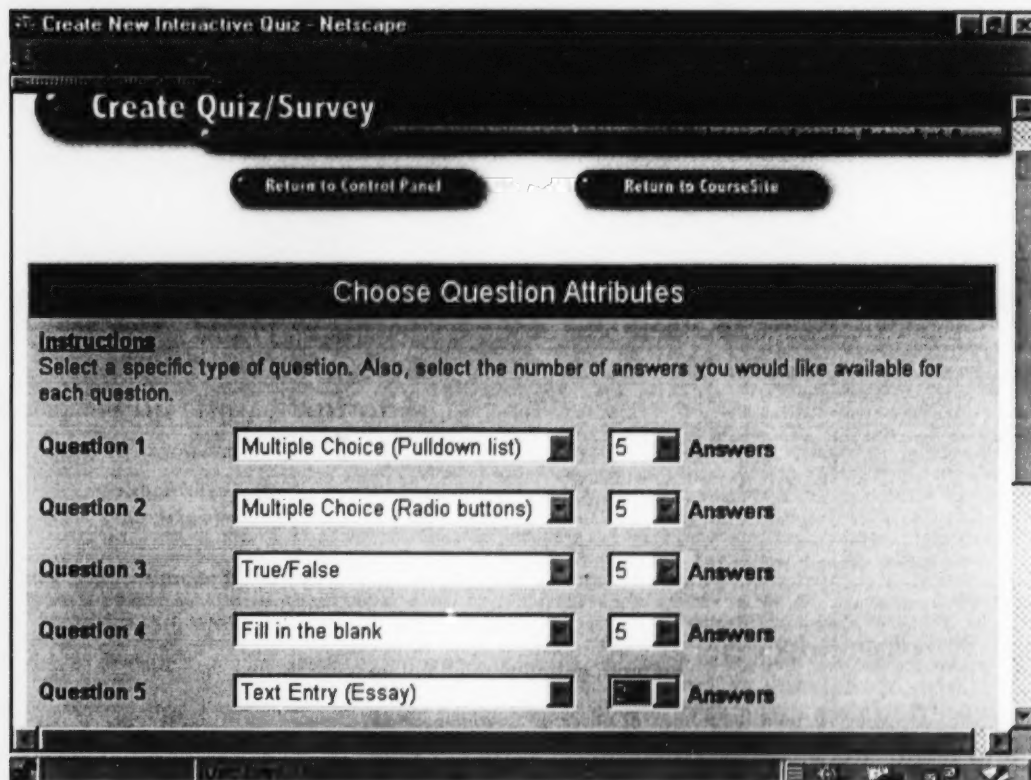


Figure 7. Another example of a commercial on-line service (Interactive Learning Network.)

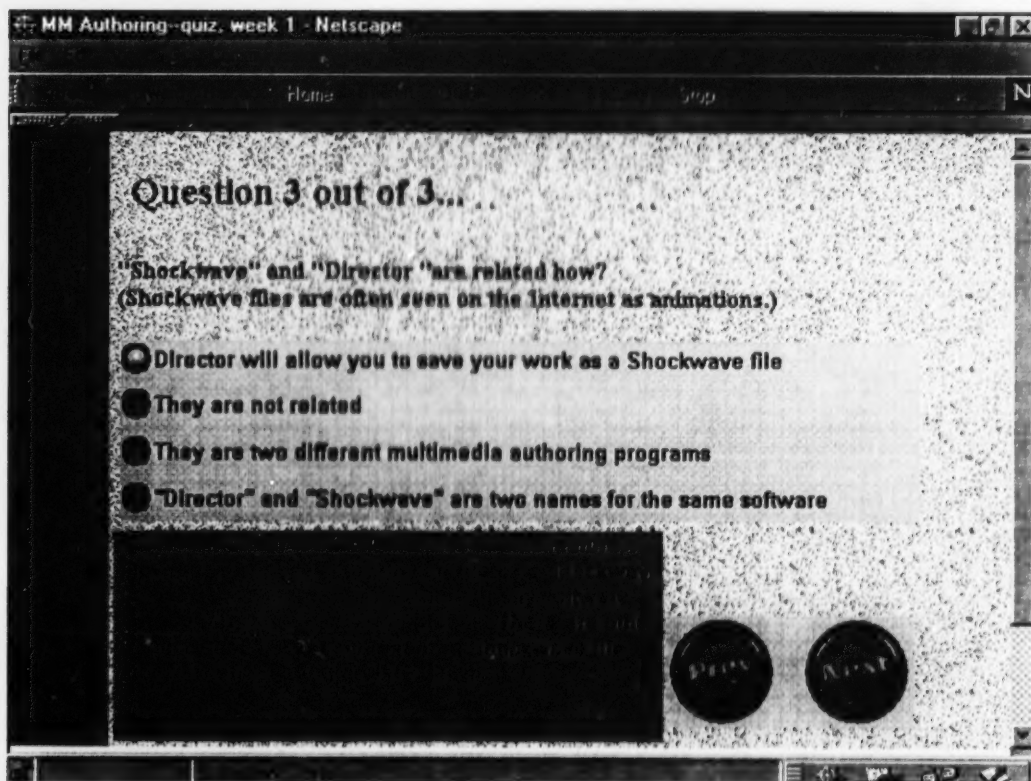


Figure 8. A web page created in Asymetrix Assistant and using Java.